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PLANNING SERVICES FOR MANAGEMENT

MANAGEMENT ISSUE REPORT

THE IMPACT OF THE
OFFICE OF THE FUTURE

DECEMBER 1980

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- discussions with client
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Management Issue Report - The
TITLE Impact of the Office of the Future.

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MANAGEMENT ISSUE REPORT

THE IMPACT OF THE
OFFICE OF THE FUTURE

DECEMBER 1980

MANAGEMENT ISSUE REPORT
THE IMPACT OF THE OFFICE OF THE FUTURE

ABSTRACT

This Management Issue Report extends INPUT's study of the impact of current office automation products and services (as detailed in Managing the Integration of Office Automation) to include new technologies. The probable impacts associated with the office of the future are forecast, with special emphasis on organizational changes and the roles of individuals in the new environments. The report details the part that data processing management should play in providing leadership in moving towards the office of the future, culminating in the establishment of an "information resource management" function.

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December 1980
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MANAGEMENT ISSUE REPORT

THE IMPACT OF THE OFFICE OF THE FUTURE

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THE IMPACT OF THE OFFICE OF THE FUTURE

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1 INTRODUCTION

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I INTRODUCTION

- In the last year, INPUT has conducted a number of studies that deal both directly and indirectly with issues affecting office automation and the "office of the future." Exhibit I-1 lists pertinent INPUT reports published as multiclient studies or as parts of subscription programs (i.e., the Planning Service for Computer and Communications Users and the Market Analysis Service for the Information Services Industry).

- In addition, INPUT has also completed a variety of related custom consulting assignments for several clients.

- INPUT's recent report entitled Managing the Integration of Office Automation, made the following critical distinctions:

  - Office automation is defined as the application of a set of products and services to improve existing, paper-based office systems and procedures.

  - Office of the future will be used to describe the application of new products and services that will cause fundamental changes in existing office systems and procedures.

- Managing the Integration of Office Automation concentrates on the management of office automation as a necessary step toward the "office of the future." It focuses on tactics rather than strategies or effects.

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EXHIBIT I-1

INPUT REPORTS PERTAINING TO OFFICE AUTOMATION
AND THE OFFICE OF THE FUTURE

- Office of the future: Opportunities for Service companies (December 1979).
- Mass Storage and Other Peripheral Devices (December 1979).
- Image Processing Systems (April 1980).
- Data Communications Considerations for New On-line Systems (May 1980).
- Personal Computers in Large Companies (September 1980).
- The Impact of Minicomputers and distributed Data Processing Networks in the 1980s (September 1980).
- Communication services for digital information: User Networks and Needs (November 1980).
- Managing the Integration of Office Automation (November 1980).

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- That report considered the concept of the "office of the future" sufficiently important to be the subject of this 1980 Management Issue Report.

- This Management Issue Report will address the following topics:

  - The current status of office automation.

  - The emerging technology that will mold the "office of the future's" development.

  - A forecast of the characteristics of the "office of the future."

  - The expected effects of the "office of the future" on both the organization and the people within it.

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II THE CURRENT STATUS OF OFFICE AUTOMATION PRODUCTS

II THE CURRENT STATUS OF OFFICE AUTOMATION

A. OVERVIEW

- Current office automation techniques will provide a base from which the "office of the future" will develop. Functions where automation is now considered an important factor include:

  - Word processing.
  - Document reproduction.
  - Computerized telephone services.
  - Image transmission (facsimile) and storage (microfilm).

- The motivating factors (sometimes in conflict) for automation have been:

  - Speed.
  - Convenience.
  - Cost savings.

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- INPUT's research on the subject suggests that, in general, there has been little planning or coordination. Most automation today is offered as a series of independent products, usually hardware devices.

  - The existence of independent products and the lack of coordination are interrelated phenomena.

B. CURRENT OFFICE AUTOMATION PRODUCTS

1. WORD PROCESSING

- At its simplest, a word processor is a typewriter with a microprocessor and a modest memory, costing under $2,000. At its most complex, it can handle text editing and photo composition with powerful processors, large amounts of data storage and sophisticated software. Definitions of word processing are not precise enough to exclude either extreme.

- Mid-range office word processors in the $10,000 to $20,000 range include a full range of features:

  - A screen that displays at least one full page of text.

  - On-line storage for several dozen pages of text (e.g., a floppy diskette).

  - A separate, low to medium-speed printer.

  - Powerful, "user-friendly" software.

- Other features that are now available will increasingly be part of the "typical system" purchased in the next five years.

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- Simple to complex data processing functions, depending on the office environment.

- Communications capabilities (estimated to increase from 5% of word processors sold to 40% in five years.)

- Clustered keyboards sharing processors, storage and printers.

- There are now over 200,000 word processors of all types installed. This number is expected to increase by a factor of five by 1985.

- Word processors with the full range of features are cost effective in any office environment that needs two or more typists. Only conservatism limits their acceptance and growth.

  - For multidraft environments, productivity increases dramatically.

  - Word processor output is higher in quality than conventional typing.

  - In spite of myths to the contrary, few typists find it difficult to adjust to the new environment. Most welcome the change and challenge.

- Word processing is the key link to the "office of the future" because it provides a method for digitizing information.

  - This is an important technical characteristic.

  - It is even more important from the standpoint of winning hearts and minds (both clerical and managerial).

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2. DOCUMENT REPRODUCTION

- Unlike the word processors, the justification for document reproduction (especially copiers) is pure convenience. There are few identifiable cost savings and certainly much extra expense is generated.

  - 1980 expenditures for copiers and supplies are estimated to be over $8 billion.

  - Besides these direct costs, there is the uncountable additional cost of transporting and handling paper, as well as management time spent reading documents of marginal value.

- Positively, however, the copier has made possible an information revolution. Like most revolutions, the clock cannot be turned back.

  - Managers who have tried to limit the use of copier facilities can testify to what a thankless and generally unsuccessful task it is.

- Document reproducers, like word processors, come in many shapes and sizes.

  - One trend has been the blurring between copiers, duplicators and computer printers.

  - A typical "leading-edge" copier/printer's features are shown in Exhibit II-1.

- There should be a doubling in copier expenditures over the next five years. This represents replacement and product segmentation more than new features or uses.

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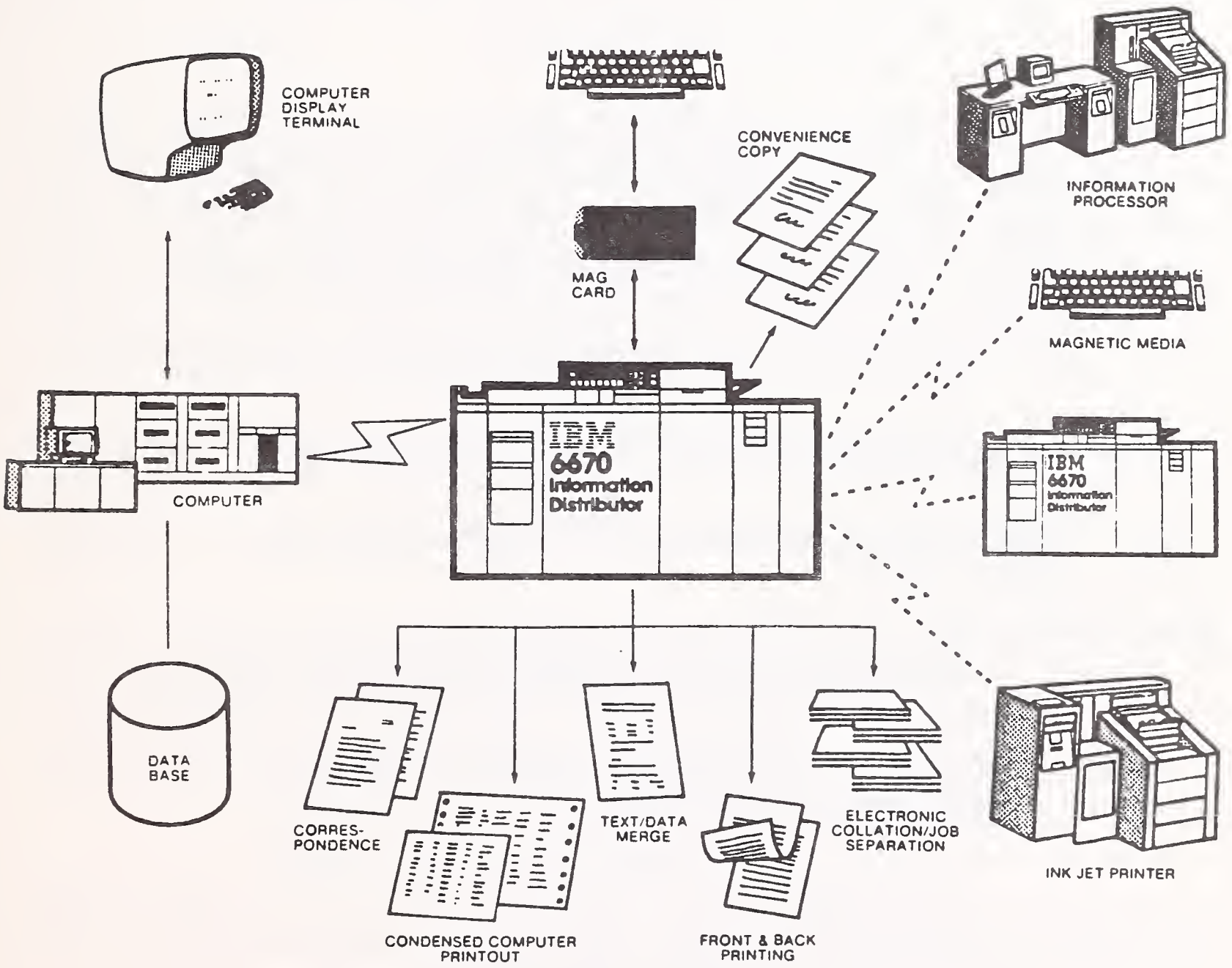
EXHIBIT II-1

A STATE-OF-THE-ART COPIER SYSTEM: IBM 6670 INFORMATION DISTRIBUTOR



COURTESY OF IBM

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3. COMPUTERIZED TELEPHONE SERVICES

- Communications will be the hub around which office automation will be integrated and coordinated. However, integrated office communications are presently more conceptual than actual, apart from a few pilot projects.

- Current offerings are not even as well defined conceptually as "word processing" or "copiers." These communication products/services have a high software content (applied to existing services).

- The Rolm Computerized Branch Exchange is an example of one type of product now in use. It allows users to access MCI Execunet and Southern Pacific Communications' SPRINT services simply by dialing "9" plus the long-distance number. It hunts for the lowest-cost communications service available at the time the call is being placed (route optimization). The system will allocate charges to users, and will produce product usage analysis reports.

  - This kind of product replaces a conventional PBX or Centrex System.

- Another type of service is the AT&T Voice Storage System, a "store-and-forward" system:

  - The Call Answering Service answers the phone after three rings. It can play a prerecorded message. The system allows the subscriber to monitor in-coming calls and to break in if appropriate. It also handles several calls if the line is busy.

  - In the message playback mode, a subscriber may listen to all or some of the recorded messages. The number of messages is indicated by the phoneset or by a dial tone interruption.

  - Monthly subscribers can have their message saved, and have the option of remote replay.

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- Advanced Calling Service allows messages to be sent to predetermined numbers. When the called party answers the phone, they are informed that a message is coming. The message is delivered and a record is made of the delivery.

- Growth rates in this sector will be very high in the next five years, but will not be too meaningful because they will be starting from a low base.

4. FACSIMILE

- Facsimile systems are intended to be used for transmitting words and images. Pictures are scanned and converted to signal waves, which are transmitted to a remote point where they are reconverted to produce a duplicate of the original. There are nearly 180,000 units installed today.

- Examples of new equipment offerings are:

  - Xerox Telecopier 485 (less than one-minute-per-page transmission).

  - Qwip 1200, and Qwip 2 (two-minutes-per-page transmission).

- Facsimile systems are generally not coordinated with other communications services and have grown up to serve a need. For example:

  - To transmit operational documents (such as drawings and reports) in preference to the slow and unreliable Postal Service or faster and reliable, but expensive, courier services.

- The use of such services has more than doubled in the last three years and is expected to triple in the coming five years.

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5. MICROFILM

- Microfilm is the oldest of the office automation tools still being used. There are three general forms:

  - Archival, usually stored in rolls, where retrieval is rare.

  - Manual retrieval systems, usually using indexed microfiche.

  - Automated retrieval systems using either roll or card-mounted microfilm, with computerized indexing and mechanical retrieval systems.

- Microfilm is relatively inexpensive, although producing the original pictures can be awkward and time consuming.

  - Updating microfilm records is virtually impossible, adding to indexing complexities.

  - Computer output microfilm (COM) eases, but does not elimate, these problems.

- Microfilm is widely used but is almost always a second choice because of its limitations. Its chief attraction is that it eliminates paper.

- COM usage is expected to be five times greater in five years; however, conventional microfilm's growth rate will be only 12-15% a year. The overall sector should about double in five years.

C. ASSESSMENT OF OFFICE AUTOMATION

- There will be significant growth in all areas of office automation (see Exhibit II-2).

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EXHIBIT II-2

RELATIVE GROWTH IN OFFICE AUTOMATION SECTORS

AUTOMATION SECTOR	1980-1985 GROWTH FACTOR
• WORD PROCESSING	5
• COPIERS	2
• COMPUTERIZED TELEPHONE SERVICES	5*
• IMAGE PROCESSING	
- FACSIMILE	3
- MICROFILM	2

*FROM A LOW BASE

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- Word processing will be the most important factor because of its high growth rate and because:

  . It starts from a higher base than computerized telephone service.

  . It is central to the operation of the office.

- Word processing and computerized telephone services are positive developments because they improve current office processes.

  - Word processing can produce a higher-quality output, faster and cheaper.

  - Computerized telephone services will make telephone use easier, more efficient and faster.

  - However, since both ultimately produce words and paper, underlying office problems are not addressed.

- Copiers, facsimile and microfilm are essentially palliatives posing as solutions to problems associated with paper documents. They all involve significant amounts of human intervention and document handling, so they are inherently expensive.

  - More importantly, they add directly to the paper problem by encouraging the generation and use of paper.

    . The demand for copiers leads to faster copiers and facsimile transmitters.

    . Then, since more copies exist than can be stored, more must be microfilmed.

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- The profusion of products to generate and expedite documents and telephoning has turned the flow of information into an unchartable flood of information.

  - The flood of information has made it more difficult to find the right information. Indexes and definitions often do not exist or are out of date.

  - Consequently, the analytic and decision-making processes that are information-dependent are often ineffective.

- INPUT's research indicates that few companies are adequately addressing office automation issues (e.g., only four out of thirty companies interviewed for a recent study had a written plan for dealing with office automation).

D. OFFICE AUTOMATION AND DATA PROCESSING

- INPUT's research has established that most EDP directors have little contact with office automation and are making few attempts to become involved. This is caused by divisions in responsibility, EDP's ignorance of office automation issues and a sense that core EDP issues and projects are more important.

- This avoidance of office automation issues by EDP management is short-sighted, in INPUT's opinion.

  - Distributed data processing and office automation must eventually be integrated. The longer this is postponed, the more difficult it will be to accomplish.

  - Most companies see, quite properly, that distributed data processing (DDP) will be the EDP issue in the 1980s. However, DDP will have to coexist, at the minimum, with all the other activities that are taking

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place in decentralized (office) settings. At best, of course, DDP and what is now called office automation will be intertwined.

- Thus, EDP management has a stark choice:

  - Get involved with office automation, or see DDP projects flounder.

E. INPUT'S RECOMMENDED COORDINATION STRATEGY

- Because of the critical need for coordination and control of office automation and EDP self-interest, INPUT made a series of recommendations for improvements in its report, Managing the Integration of Office Automation, which are summarized below.

- As shown in Exhibit II-3, there should be an Information Resources Director responsible for:

  - Data processing.

  - Communications (voice, data and message).

  - Information administration (manual and automated office systems).

- Information flows and the communications that support them should be viewed as central to office processes. This makes the role of the Information Administrator critical, as diagrammed in Exhibit II-4.

  - Manual system policies and general approaches should be administered centrally.

  - Automated office support systems should be planned from an integrated standpoint.

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EXHIBIT II-3

RECOMMENDED INFORMATION RESOURCES ORGANIZATION

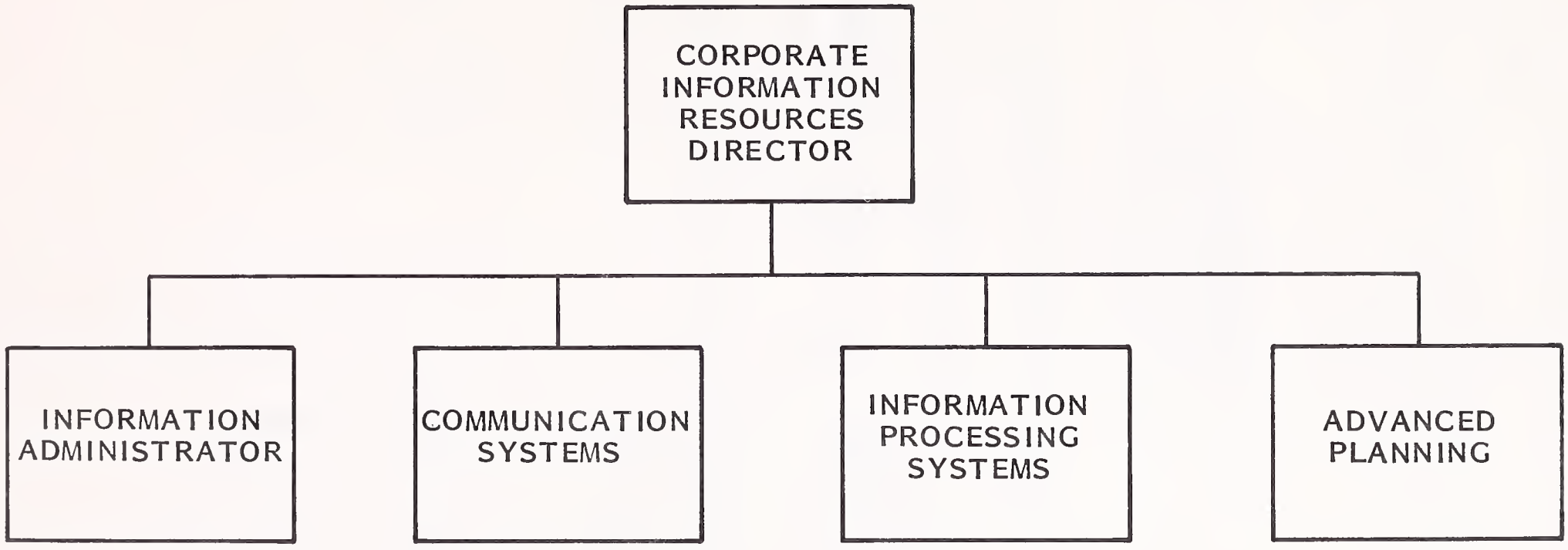

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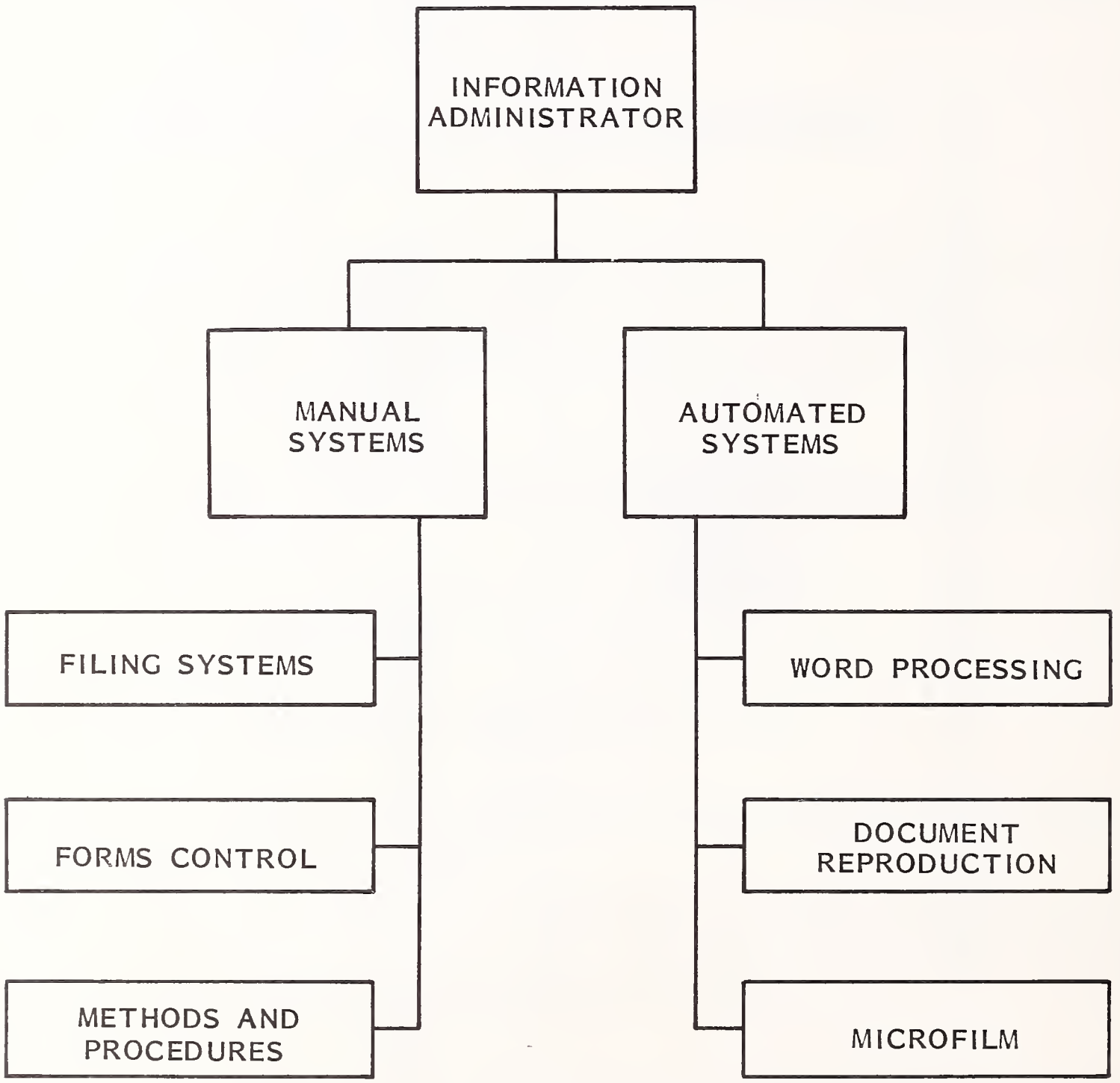
EXHIBIT II-4

THE INFORMATION ADMINISTRATION FUNCTION



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- Most importantly, the manual and automated systems themselves should be coordinated.

- The EDP data base administration function should be expanded to include the analysis and documentation of all office-oriented information flows.

- The Information Resources Management function would be responsible for policy setting and hardware selection in all areas, although actual line operations would not necessarily report to the Information Resources Division.

- In INPUT's opinion, without this level of coordination and integration:

  - Many of the synergistic benefits of office automation will not occur.

  - More advanced technology cannot usefully be absorbed by the automated office.

  - The "office of the future" could be indefinitely postponed.

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III EMERGING TECHNOLOGY FOR THE OFFICE OF THE FUTURE

III EMERGING TECHNOLOGY FOR THE OFFICE OF THE FUTURE

- There are two prerequisites to establishing the "office of the future." The previous chapter described the first:

  - Coordinating and integrating existing office automation products and processes.

- The other prerequisite is the controlled absorption of new technology. There are four areas of technology involved:

  - Image processing.

  - Inexpensive mass storage.

  - Personal computers.

  - Digital office communications networks.

A. IMAGE PROCESSING

- Optical Character Recognition (OCR) has been in existence for years, converting printed input into digitized data. OCR has never caught on except in a few specialized EDP applications. Its usage is small and expected growth is low. It is not expected to contribute significantly to office automation.

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- In contrast, there is great potential for image processing systems, which can read all the material on a page. Exhibit III-1 gives an overview of a currently operational product. The approach in Exhibit III-1 has several advantages:

  - The entire document can be stored and/or the document (or a portion of it) can be treated as a form with data extracted for processing, as in traditional OCR processing.

  - There are two types of storage:

    . An indexed document image file.

    . A digitized data file for computer processing.

  - Indexes can be generated directly from the documents themselves; unlike microfilm, where indexes must be manually generated.

B. INEXPENSIVE MASS STORAGE

- Since the introduction of the IBM 360, disk storage prices have fallen by roughly two orders of magnitude, as shown in Exhibit III-2. This has made many more data processing applications economically feasible.

  - However, disk storage is still very expensive for storing images (e.g., it would cost about $10 to store a page image on a 3380).

- Video disk storage, however, changes this situation dramatically. A single video disk pack can hold 10^{12} bits, and systems are projected that will accommodate 10^{15} bits. Even at 500,000 bits per page, the current and projected video disks represent two million and two billion pages of storage respectively.

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EXHIBIT III-1

A STATE-OF-THE-ART IMAGE PROCESSING SYSTEM

(VIPS - 2000)

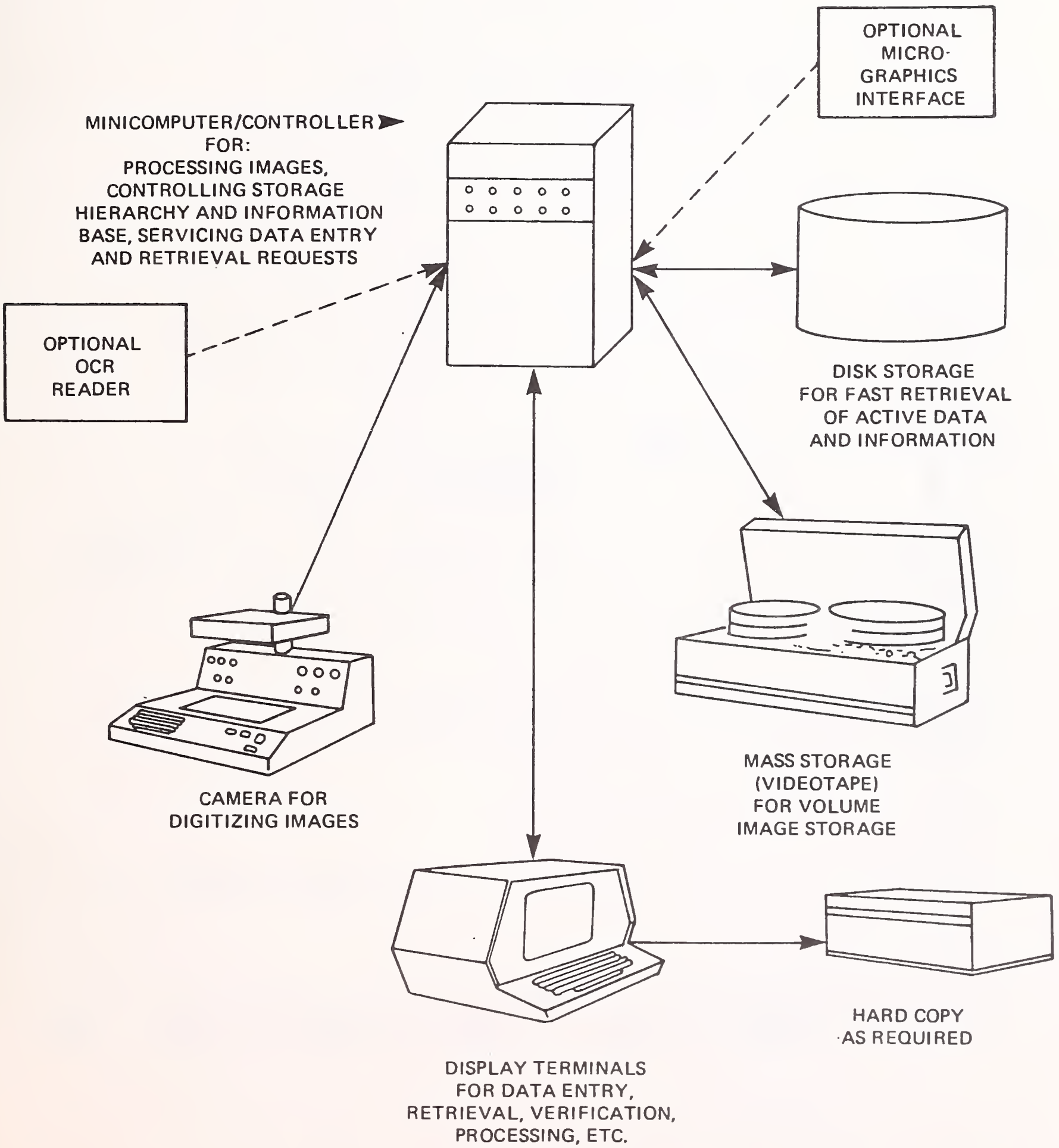
OPTIONAL MICRO-GRAPHICS INTERFACE
MINICOMPUTER/CONTROLLER FOR: PROCESSING IMAGES, CONTROLLING STORAGE HIERARCHY AND INFORMATION BASE, SERVICING DATA ENTRY AND RETRIEVAL REQUESTS
OPTIONAL OCR READER
DISK STORAGE FOR FAST RETRIEVAL OF ACTIVE DATA AND INFORMATION
CAMERA FOR DIGITIZING IMAGES
MASS STORAGE (VIDEOTAPE) FOR VOLUME IMAGE STORAGE
HARD COPY AS REQUIRED
DISPLAY TERMINALS FOR DATA ENTRY, RETRIEVAL, VERIFICATION, PROCESSING, ETC.

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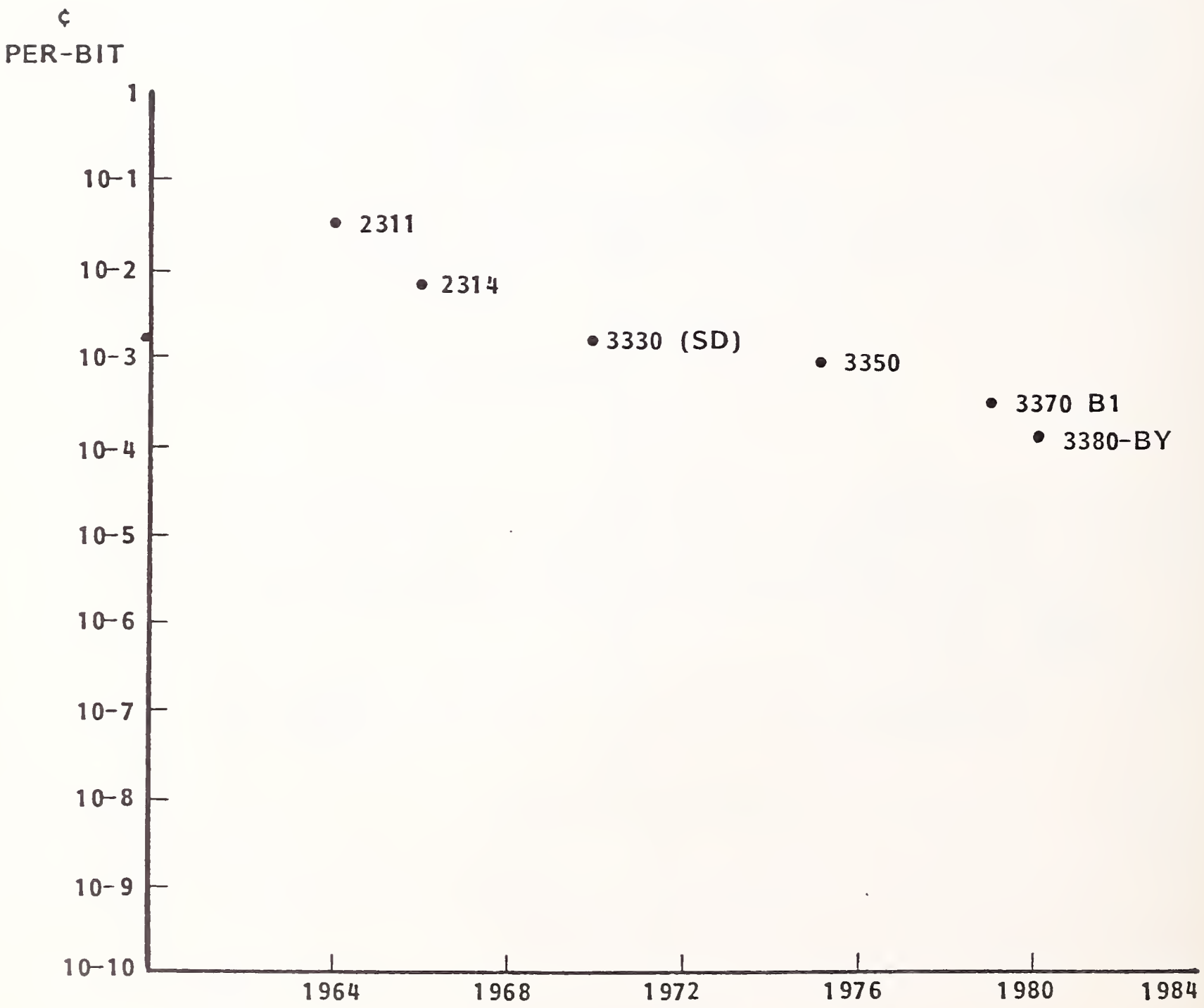
EXHIBIT III-2

IBM DISK STORAGE PRICING TRENDS



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- Two billion pages is enough to store the contents of two million books of 1,000 pages each. To store this library would require over 50 miles of shelf space.

- The 10^{15} bit capacity video disk system will fit into a 325 square-foot room. Equivalent tape storage would require an eight-acre building.

- This same video disk system can store the equivalent of 20 billion pages of computer printout. That is over three million miles of paper. To store these paper files would require a building with over 250 acres of floor space.

- Video disk cost per bit will be 4 or 5 orders of magnitude less than current disk costs, as shown in Exhibit III-3. This would equate to storage costs of a fraction of a cent per page.

  - This is one-tenth as expensive as magnetic tape storage (which, in any event, would not be practical for office automation).

  - It is also considerably cheaper than other storage systems under development. The latter would, however, offer faster access and would therefore be more suitable for indexes and frequently used image files.

- Video disks share the defect of microfilm in that a record cannot be easily updated. However, its low cost and ease of indexing make this a relatively minor flaw.

C. PERSONAL COMPUTERS

- A personal computer system is defined in INPUT's study, Personal Computers In Large Companies, as follows:

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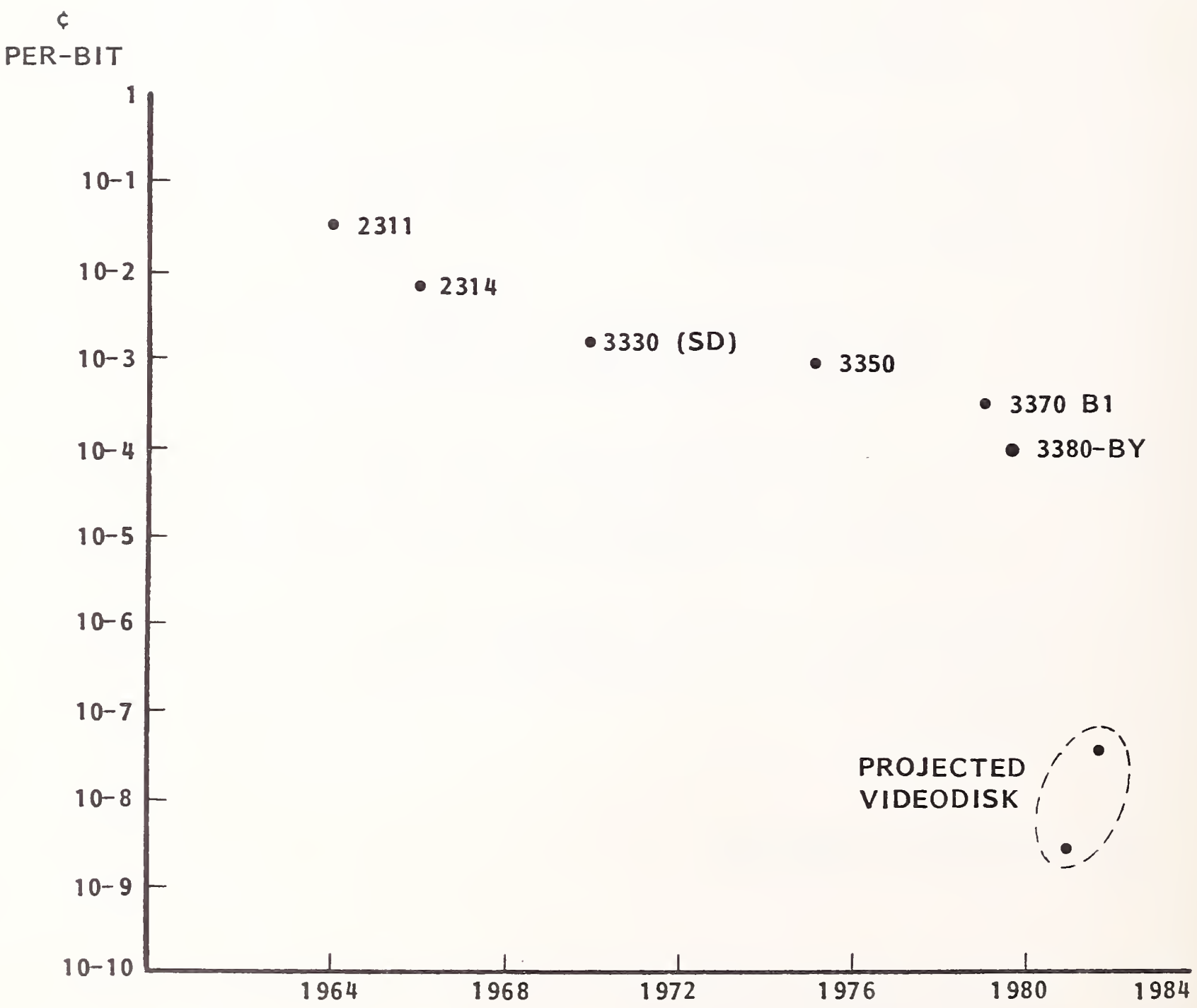
EXHIBIT III-3

PROJECTED VIDEODISK STORAGE COSTS



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- A personal computer sells in a minimally useful configuration for less than $15,000.

- It is capable of operating in a standalone mode, but may also operate in a network.

- The configuration includes a CPU with memory, a display unit, a printer and some external storage. The external storage is used in a business environment as an aid in performing one's job.

- Systems used in process control, process automation, dedicated word processing or dedicated data entry, are not considered personal computers.

- According to INPUT's research, there are now 85,000 personal computers in use in large companies. This number is expected to increase by a factor of seven by 1985.

- INPUT's multiclient study, Personal Computers In Large Companies, investigated the extent of use of personal computers in a number of corporate departments.

  - Taking marketing departments as an example, personal computers are now being used for an extraordinarily wide variety of applications, as shown in Exhibit III-4.

  - Some of these uses had little to do with marketing!

- If personal computers gradually become established without central planning, it will only gradually become apparent that:

  - Word processors and personal computer systems will have a great many technical features in common so that, with minor modifications, they can be used interchangeably.

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EXHIBIT III-4

USES OF PERSONAL COMPUTERS IN REPRESENTATIVE MARKETING DEPARTMENTS

- Business planning.
  - Profit and loss model for branches.
  - Real estate analysis to determine branch sites.
  - Report and policy productivity analysis.
  - Forecasting through data base (demographics).
  - Price forecasting.
  - Modeling/forecasting.
- Market research.
  - Demand deposit accounting customer base analysis.
  - Mutual fund account value.
  - Risk analysis.
- Sales administration.
  - Branch performance measurement.
  - Quota assignments by territory.
  - New business tracking, RFP tracking.
- Sales analysis.
  - Lost account analysis.
  - Probate analysis.
  - Policy file for management reports.
- Sales support
  - Marketing mailing labels.
  - Group pension plan proposals.
- Non-marketing functions.
  - Inventory functions.
  - Purchasing.
  - Customer estate planning.

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- Personal computer systems will perform functions now offered by the corporate EDP department, or will duplicate data separately collected and maintained in the corporate data base.

- It is important to note, though, that the coordination and "coming-together" of word processing, personal computers and distributed data processing cannot, beyond a certain point, be forced by senior management directives. The different classes of users in the office environment must be allowed to discover some of the problems (and solutions) themselves, even at some loss of time and money.

  - It is instructive that hardware manufacturers have not yet succeeded in producing widely accepted combined word processors/small computers.

    . System designers and especially users tend to focus on either data or word processing.

    . Even now, purchasers (not to mention users) of word processing equipment are quite separated from data processing users: organizationally, physically and psychologically.

  - Only after enough word processors and small computers are sitting side by side (perhaps because both need some special air conditioning) will the light begin to dawn.

- Even if personal computers establish themselves independently of any outside coordination, the "office of the future" could still be created. However:

  - Much time will have been lost.

  - Duplicate, irrecoverable investments will have been made.

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- Additional resources will be consumed in untangling and reconstructing systems and processes based on word processors, personal computers and distributed data processing systems.

D. DIGITAL OFFICE COMMUNICATIONS NETWORKS

- As with personal computers, communications network systems and products are no longer a matter of conjecture, but actually exist. There are two basic types of networks involved:

  - Long-distance networks.

  - Local networks, often for use in a single building.

- The circuit-switched public telephone network, along with private line services from AT&T, will continue to play a major role in data communications for quite some time. Nevertheless, there are situations where alternate offerings may be more cost effective. Examples:

  - Specialized offerings from AT&T (e.g., FX and CCSA).

  - Standard and specialized services from other common carriers (e.g., Western Union).

  - Offerings from specialized common carriers, including Sprint and Execunet.

  - Packet-switched data networks for widely dispersed, low-volume, interactive terminals.

  - Remote computer services (RCS) networks.

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- Satellite services where wideband transmission and broadcasting capability are important.

- Although both ACS from AT&T and Xten from Xerox appear to be bogged down, the capabilities that were planned for them will undoubtedly be reintroduced.

- Local networking techniques, developing rapidly, are commercially available from a number of sources. Numerous companies are developing and/or offering local networking systems whose ultimate goal is to connect a variety of products from a variety of vendors together in a relatively small geographic environment, independent of codes, protocols and speeds. These kinds of products will serve as the foundation of the "office of the future." Examples:

  - Datapoint offers Light Link, which uses modulated infrared to transmit messages up to two miles.

  - Valtec Corporation (Communications Fiberoptics Division) links a host computer at Grumman Aerospace Corporation with high-resolution graphic terminals over a three-kilometer fiber optics line.

  - Exxon Enterprises' subsidiary, Optical Information Systems, manufactures semiconductor laser transmitters and receivers capable of transmitting six million bits per second over a single fiber.

  - Wang's WISE (Wang Inter System Exchange) enables up to 96 workstations to access each other, or any other device in the network, up to one and one-half miles away. Data transfer is via coaxial cable, at speeds up to four megabits per second.

  - Xerox's Ethernet, tested at the White House, is also a passive coaxial cable link. It can string together any number of Xerox 860 Information Systems (DP and WP capability) and enables access to any other part of the system via Xten or any other common carrier.

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- Xten would interconnect subscribers within a given city via microwave links for transmitting/receiving through a single satellite earth station, regardless of code, protocol or speed.

- A consortium of Xerox, DEC and Intel is currently developing the specification for a low-cost local communications network based on Ethernet, which will be licensed to anyone who wants to build products for it. The Network 9 design will be non-proprietary.

- Telesystems Network, Inc. is facilitating the mix-and-match approach to office automation by providing a Protocol Translator that enables almost any word processor or computer to communicate with almost any other. The accounting firm of Laventhol and Horvath has used the product to convert from Vydec to Lexitron word processors. Each unit costs about $8,000, and rents for $450 per month, including maintenance.

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IV CHARACTERISTICS OF THE OFFICE OF THE FUTURE

IV CHARACTERISTICS OF THE OFFICE OF THE FUTURE

- INPUT's judgement is that the "office of the future" will be defined by the presence of these characteristics:
  - A uniformly automated network.
  - Digital storage of virtually all information.
  - Data input and output via multipurpose terminals.

A. A UNIFORMLY AUTOMATED NETWORK

- The network in the "office of the future" will have a hierarchy of processing and storage, as shown in Exhibit IV-1.
  - Data that have been generated or received locally will be stored and indexed at the local level.
  - There will be one or more layers of intermediate processing. Storage and indexing (for example, at the division level in a multidivision company).

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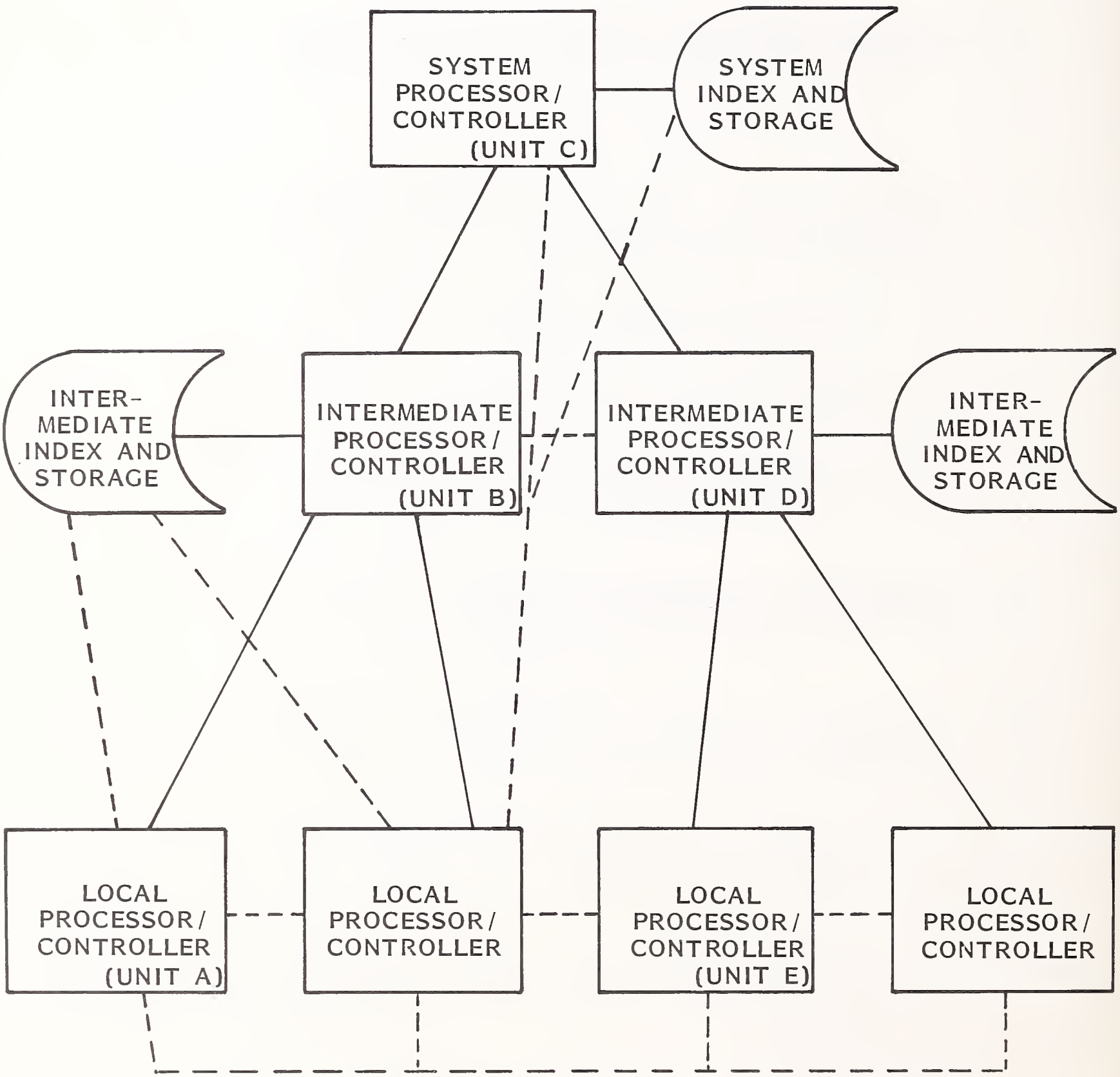
EXHIBIT IV-1

NETWORK RELATIONSHIPS IN THE "OFFICE OF THE FUTURE"


SYSTEM PROCESSOR/ CONTROLLER (UNIT C)
SYSTEM INDEX AND STORAGE
INTER-MEDIATE INDEX AND STORAGE
INTERMEDIATE PROCESSOR/ CONTROLLER (UNIT B)
INTERMEDIATE PROCESSOR/ CONTROLLER (UNIT D)
INTER-MEDIATE INDEX AND STORAGE
LOCAL PROCESSOR/ CONTROLLER (UNIT A)
LOCAL PROCESSOR/ CONTROLLER
LOCAL PROCESSOR/ CONTROLLER (UNIT E)
LOCAL PROCESSOR/ CONTROLLER
= NORMAL LINKS
= ALTERNATE LINKS (EXAMPLES)

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- Intermediate indexes would be complete; i.e., would contain all the data in each local index under it in the hierarchy. Normally, however, only summaries or excerpts of local data would be permanently stored at the intermediate level.

- The main system processor, index and storage, would represent a further level of obstruction. (For example, this level would summarize the entire corporation.)

- When a local processor needs data that are not under its own control, it would normally send its request through the hierarchy. For example:

  . If processing unit A needed data that were located in processing unit E, it would proceed through B, C and D.

  . However, if the normal links were unavailable, then alternate direct links would be established. The network will be a very robust one.

  . At the lowest level in the hierarchy, the individual work units would be self-contained for carrying out normal activities, as shown in Exhibit IV-2.

- A critical element in defining the "office of the future" will be the extent of uniformity in automation. This uniformity will exist on two levels:

  - The various pieces of equipment will be able to communicate with each other. (This will be eased with developments such as Ethernet.)

  - Equally important, functions will be automated to the same depth across all work units, otherwise work units will not be able to communicate and much of the advantage of office automation will have been lost.

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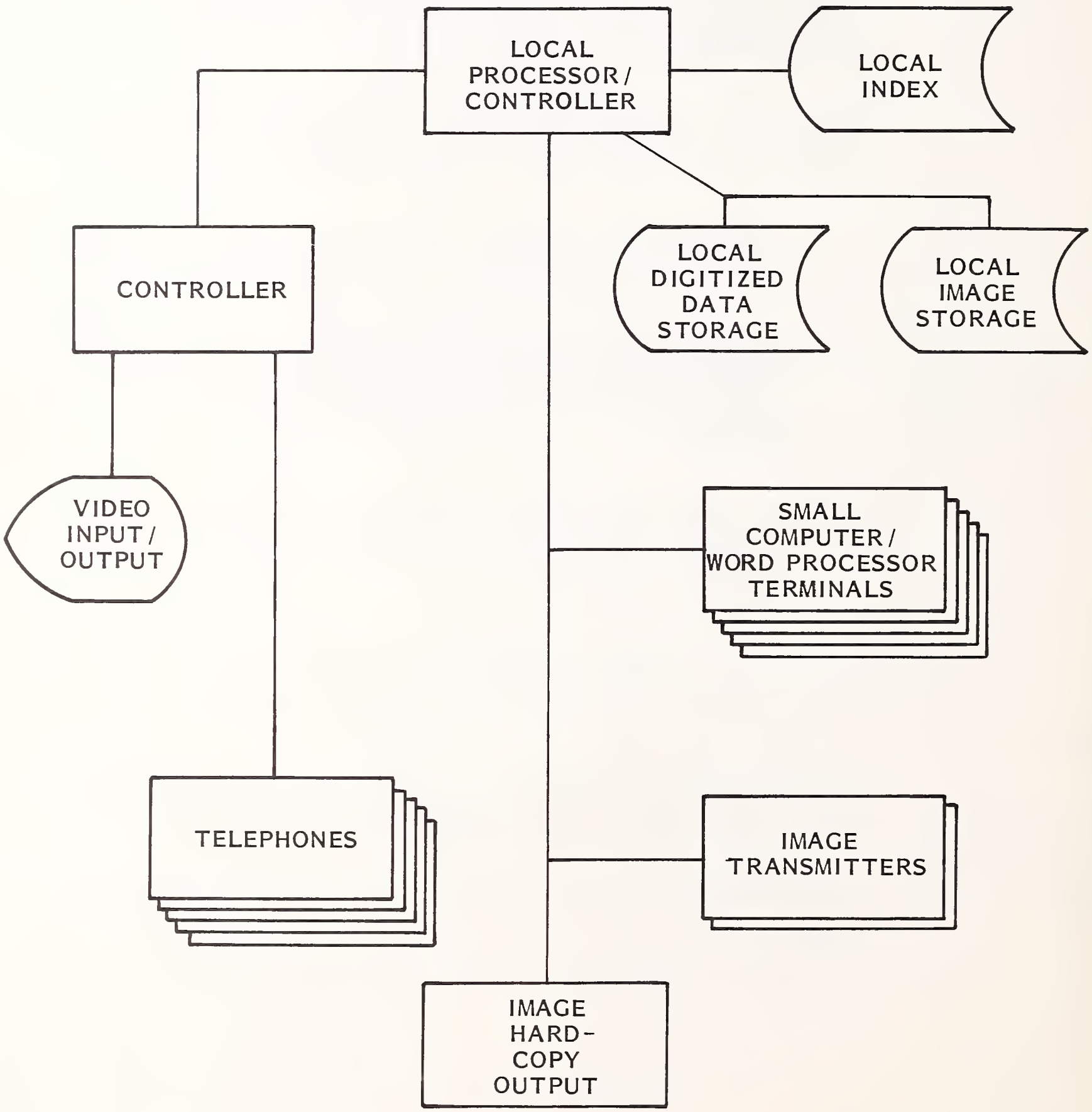
EXHIBIT IV-2

A WORK UNIT IN THE "OFFICE OF THE FUTURE"



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- An example of the problem of incomplete automation is shown conceptually in Exhibit IV-3. This is a six-node network in conceptual form, with all nodes of the same importance, but with one node not automated (or not connected to the network).

  . With one node unreachable, the other nodes must send and receive 20% of their transactions by alternate, less desirable means (perhaps paper documents).

  . Looking at the entire network (or organization), fully one-third of the transactions must take an alternate form or use an alternate form of communication.

B. DIGITAL DATA STORAGE

- If the communication network will be the skeleton of the "office of the future," then the body will be digital storage of the information used (in whatever form) for office functions.

- The objective will be a "paperless office." Naturally, paper will never be totally eliminated, but it can be greatly reduced. More significantly, the important pieces of information will be stored digitally (with, at most, the occasional paper copy).

  - In the past, there has been a certain glibness associated with the concept of the "paperless office." Exhibit IV-2 showed that to truly accomplish this, major changes will be required.

  - Some of these changes will be technical (discussed in Chapter III).

    . Equally significant changes will be behavioral. These will be discussed in Chapter V.

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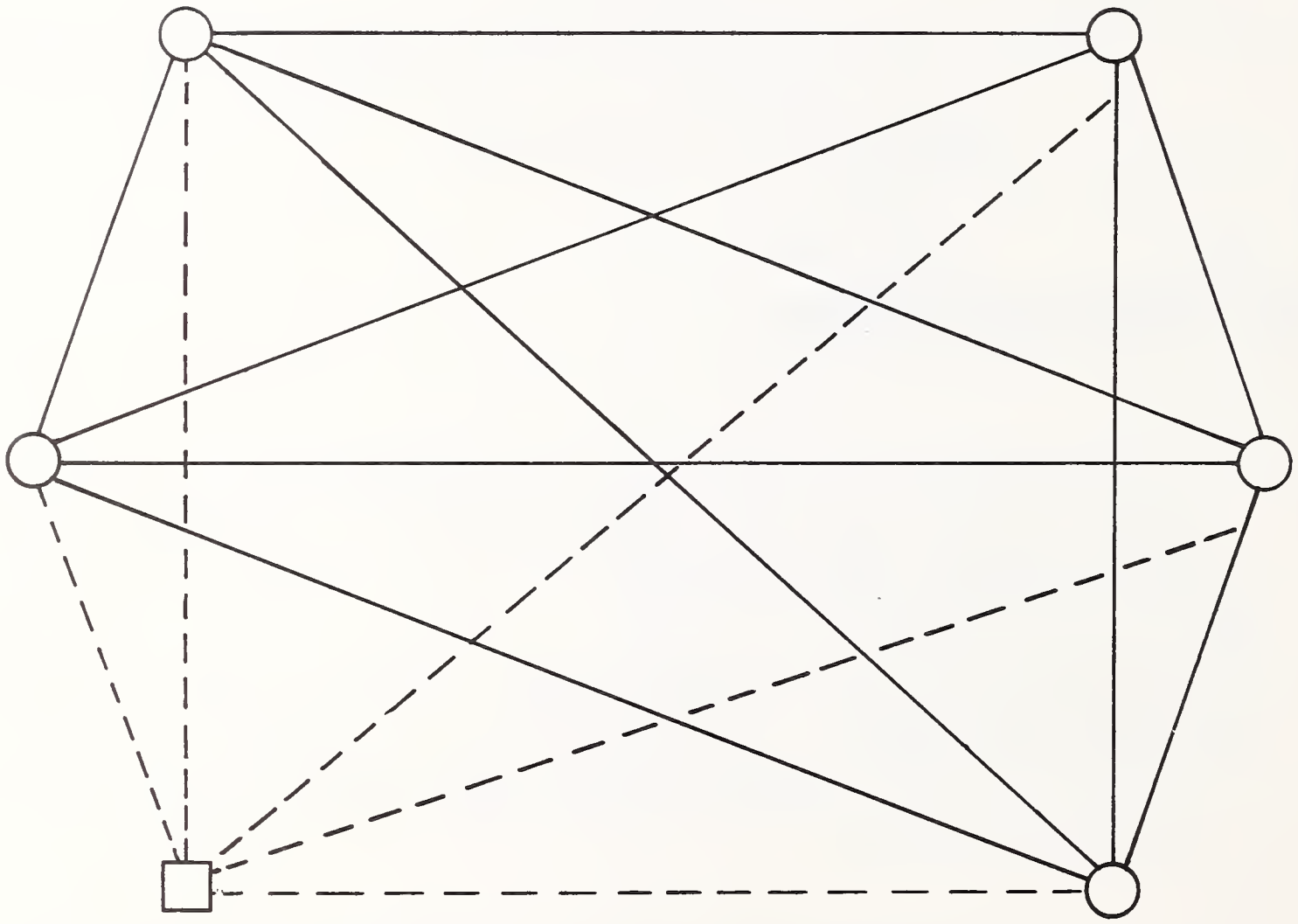
EXHIBIT IV-3

A NETWORK WITH
AUTOMATED AND NONAUTOMATED NODES



○ = AUTOMATED NODE

□ = NONAUTOMATED NODE

——— = AUTOMATED COMMUNICATION

- - - - = NONAUTOMATED COMMUNICATIONS

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- Data generated or used by a work unit will be stored locally.
  - Digitized data (i.e., that used by word processing) will use rapid-access disk-type storage (magnetic media or an improved replacement).
  - Image data will be stored on video disks. Access will be somewhat slower, but storage capacity will be immense.
- Subsets of local data will be combined and stored centrally (and, in some cases, at intermediate points as well).
  - Digitized data will form the EDP data base.
  - Image data will serve as the central files.
- There will be local and central indexes for all classes of data.

C. MULTIPURPOSE TERMINALS

- Extensive use of terminals will be obligatory, with digitized data access by a communications network.
- The present proliferation of terminal types will no longer exist.
  - Word processing machines and small computers will be functionally identical.
  - Hardware will be internally redundant and very reliable.
  - All digital data terminals will have extensive graphics capability (united with nonkeyboard input as an option).

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- Much data will be digitized at the point of origin (e.g., word processing), reducing the present level of need for image processing and storage.

- However, there will always be a significant requirement for image processing and storage (e.g., from external, nondigitized sources).

  - Image input devices will transform paper copy to digitized images.

  - Image printers will produce hard copy of either digital or image data if required.

- Voice (telephones) and video terminals will be part of the network.

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V THE EFFECTS OF THE OFFICE OF THE FUTURE

V THE EFFECTS OF THE OFFICE OF THE FUTURE

- The "office of the future" will have impact in several different ways.

  - It will change the distribution of office activities, making office work more productive.

    . The roles of some staff categories will change significantly.

    . Organizational behavior will change.

  - The organization's structure and the way it performs its business will be significantly changed.

A. CHANGES IN THE KINDS OF ACTIVITIES PERFORMED

1. CURRENT DISTRIBUTION OF OFFICE WORKFORCE ACTIVITIES

- Exhibit V-1 provides a breakdown of office work by current job category and activity.

  - Nearly half of office work consists of creative work; i.e., analyzing and originating documents.

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EXHIBIT V-1

PERCENT OF OFFICE LABOR ATTRIBUTABLE TO VARIOUS ACTIVITIES (1978)

JOB FUNCTION	ORIGINATION OF DOCUMENTS (1)	HANDLING DOCUMENTS (2)	USING TELEPHONE	FACE TO FACE (3)	TYPING	ANALYTICAL WORK (4)	TOTAL
MANAGERS AND ADMINISTRATORS	7%	2%	7%	9%	0%	4%	29%
PROFESSIONALS AND TECHNICAL	6	4	7	13	0	15	45
CLERKS AND TYPISTS	1	8	2	1	4	4	20
SECRETARIES	1	1	1	1	1	1	6
TOTAL PERCENT	15%	15%	17%	24%	5%	24%	100%
EQUIVALENT IN $ BILLION	$124	$124	$140	$198	$41	$198	$826

(1) INCLUDES DICTATION, WRITING MEMOS, LETTERS AND REPORTS. EXCLUDES TYPING.
(2) INCLUDES FILING, COPYING, ROUTING, MAIL HANDLING. EXCLUDES TYPING.
(3) INCLUDES MEETINGS, PRESENTATIONS, SEMINARS, CONFERENCES.
(4) INCLUDES DESIGN, CALCULATION, TECHNICAL READING.

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- Almost as much time is consumed by communication, either face to face (e.g., meeting, presentations, etc.) or by telephone. Telephone time is especially inefficient, with only about 10% being productively spent. (See INPUT's Managing the Integration of Office Automation in the EDP Environment.)

- Only one-fifth is spent on classic "office" functions, typing and document handling.

- The current goals of office automation have been to improve traditional paper processing. However, the most significant payoff from the "office of the future" will come from making communications and creative work more efficient.

  - Over $800 billion was spent on office labor in 1978, over one-third of the GNP.

2. DISTRIBUTION OF WORKFORCE ACTIVITIES IN THE OFFICE OF THE FUTURE

- The restructuring of functions in the "office of the future" will have a significant impact on the distribution of activities and, equally important, on job categories.

  - It is very important for the Information Resources Director to understand and foresee these changes.

    . The Information Resources Director will be the interpreter of these changes to the rest of the organization.

    . If today's EDP director is to become (and remain) tomorrow's Information Resources Director, it is critical that he or she understand the magnitude of the changes involved.

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- INPUT sees the most obvious impact being on clerks and typists, since far fewer will be required.

  - While typing will remain constant, half will be transferred to professionals originating their own data.

  - Document handling and analytical work (mainly inefficient listing and calculations) will be largely replaced by machines responding directly to the professional requiring the information.

  - Communication and document origination tasks will diminish.

- Secretarial work, in INPUT's view, will be reduced by at least half. A greater decrease will occur if executives give up personal secretaries.

- Executives will have their time affected least, for a mixture of good and bad reasons:

  - It is doubtful if executives will do any significant amount of direct interaction with machine systems, even where this would be efficient. This is a mixture of inability to type and fear of losing status.

  - INPUT research has found that executive users of current "electronic mailbox" systems send two messages a day on the average.

    . This is in spite of the fact that middle management is supposed to be the prime beneficiaries of such services.

    . This is much lower than projections made by organizations not yet using such a service.

  - However, much executive interpersonal time that is not objectively productive is, in fact, productive on a deeper level. For example:

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. Building consensus.

. Selling ideas.

. "Psyching out" the other side.

- Consequently, INPUT expects no more than one-quarter of existing executive communication time to be replaced with teleconferencing or electronic mail.

- Similarly, few changes in analysis or document origination work done by executives should be expected since so much of this work is conceptual and creative rather than data-driven.

- INPUT expects the most significant changes to affect the professional/technical staff (which also now accounts for half of all office time). These changes will be in the use of time as well as in the work process and product.

- Much analytic work now is made extremely inefficient by difficulties in assembling and working with data, and coordinating information from other people. INPUT estimates that this process will be twice as productive in the "office of the future."

- Up to three-quarters of current meetings, telephoning, etc., can be replaced by the more efficient facilities of the "office of the future." As cited earlier, these new processes should require only 10% as much time as the communication means they replace.

- This magnitude of improvement is realistic, since most professional personnel see meetings as a means of transferring information rather than an integral part of the management process (as executives view them).

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- Professional personnel also have far less "keyboard fright" or status to lose than executives. Being younger, they are more flexible and more used to dealing with machines.

- Professionals' morale should increase as they are able to accomplish their assignments faster, usually with better results. The information they will be dealing with will be more timely and complete.

- Exhibit V-2 restates Exhibit V-1, using the projected adjustments described above. These figures indicate that three-fifths as much labor should be required to perform what is currently being achieved. The potential for improvement is enormous, even allowing for slippage, additional capital costs of the "office of the future" and differences in assumptions.

  - Note than over half the improvement comes from professional and managerial productivity improvements.

  - The professional productivity improvement is especially important since it strongly suggests that many technical and analytical projects will be completed much faster than they are now, while the quality of the work will be at least as high.

- Quality issues are especially important to understand, since the usual objection to performing a task faster and cheaper is that quality must suffer. This objection will not apply to the "office of the future."

  - Data used in analysis will be easier to assemble, better understood, more complete, more accurate and fresher than is now the case, where data must be assembled from diverse and often contradictory sources.

- While the communication process will consume less professional time, all necessary viewpoints and information sources can be involved, regardless of the numbers of people involved or the distances between them.

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EXHIBIT V-2

PERCENT OF OFFICE LABOR ATTRIBUTABLE TO VARIOUS ACTIVITIES
IN THE "OFFICE OF THE FUTURE"

JOB FUNCTION	ORIGINATION OF DOCUMENTS (1)	HANDLING DOCUMENTS (2)	USING TELEPHONE	FACE TO FACE (3)	TYPING	ANALYTICAL WORK (4)	TOTAL
MANAGERS AND ADMINISTRATORS	7.0%	2.0%	6.0%	6.5%	0.0%	4.0%	25.5%
PROFESSIONALS AND TECHNICAL	6.0	4.0	2.0	4.0	2.0	8.0	26.0
CLERKS AND TYPISTS	0.0	2.0	0.0	0.0	2.0	1.0	~~0.5~~ 5.0
SECRETARIES	0.5	0.5	0.5	0.5	0.5	1.0	3.5
TOTAL PERCENT	13.5%	8.5%	8.5%	11.0%	~~45.0%~~ 4.5	14.0%	60.0%
EQUIVALENT IN $ BILLION							

(1) INCLUDES DICTATION, WRITING MEMOS, LETTERS AND REPORTS. EXCLUDES TYPING.
(2) INCLUDES FILING, COPYING, ROUTING, MAIL HANDLING. EXCLUDES TYPING.
(3) INCLUDES MEETINGS, PRESENTATIONS, SEMINARS, CONFERENCES.
(4) INCLUDES DESIGN, CALCULATION, TECHNICAL READING.

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- They will only have to be involved to the extent necessary, no longer attending a two-hour meeting to make a five-minute contribution.

- An often overlooked benefit to electronic conferencing and electronic mail is that written documentation and an audit trail will be automatically produced. (Accurate summaries and indexes will be an absolute requirement.)

B. CHANGES IN ORGANIZATIONAL BEHAVIOR

- The way that the organization conducts its business will be significantly affected in the "office of the future" by the impact of technology and by the changes in workforce activities and roles.

  - Communications (e.g., meetings and messages) will be handled much differently.

  - The concept of the central file will be reestablished.

  - The office copier (and all that it implies) will cease to exist as we know it.

  - The use of paper documents will decline markedly.

- To some extent these changes will occur gradually and naturally. However, it will be part of the mission of the Information Resources Director:

  - To make others in the organization understand the reason for the changes. Expectations should be neither too high nor too low.

  - To ensure that the technology is there in the time and quantities needed. Growth will not always be steady, but will occur in spurts.

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Good planning, a finger on the organization's pulse and some luck will be required to keep the pipeline filled with hardware and technical staff.

I. COMMUNICATIONS

a. Telephones

- Telephone calls are now a worse problem than meetings in that, whether or not a call gets through, someone's time is wasted (either in waiting or in being interrupted). The apparently successful telephone call is sometimes even more of a problem since the called party is usually unprepared for the call and provides incomplete, unorganized and sometimes incorrect information.

  - Either electronic mail or store-and-forward voice systems will allow messages to be recieved at an appropriate time and, more importantly, will allow for an orderly response.

  - The ability to work undisturbed by telephone calls will no longer be a luxury enjoyed by a very few.

b. Meetings

- Currently, many organizations' staffs spend so much time meeting about things that they have little time to do them!

  - Most meetings are run badly and accomplish much less than is possible. Effective techniques to remedy this are not used, mainly because they require imposing structure on people's behavior (e.g., avoiding dominance, keeping on the subject, making sure all parties leave the meeting with a common view of what happened).

  - Teleconferencing and especially electronic mail will impose much of the required structure automatically.

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- The change will be most marked on the professional and technical staffs whose meetings are often devoted to problem definition, fact finding and planning specific actions.

- Executive use of the telephone for business purposes would decrease somewhat, but would not change in its essentials.

- Use of the telephone by other staff levels for business purposes would decrease to the point that there would be long-term organizational effects.

  - As these people moved into management, they might bring many of the "office of the future" communication habits with them.

  - Whether a significant decrease in interpersonal contact by senior management would be a good or bad thing is a matter of conjecture.

- An interesting option open to the organization will be to greatly reduce the use of the firm's telephones for personal business. This has certain superficial attractions. However:

  - It would weaken morale and severely inconvenience many employees.

  - Going elsewhere to use public telephone will add in-transit time and free employees from in-office constraints on personal telephone use.

  - More importantly, to the extent that the "office of the future" encourages working at home, trying to monitor personal behavior would be self-defeating.

- A hybrid form of meeting/message service will emerge in the "office of the future," taking advantage of the unique attributes of electronic mail.

  - The "slow-motion" meeting or, conversely, the very fast exchange of electronic memos.

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- An initial outline or memo would be transmitted to interested parties and, during the course of the day, data would be added or questioned, courses of action commented on and alternate approaches proposed.

- This would combine the reflection and analysis possible in current written communications with the speed of face-to-face meetings.

- What now takes weeks to accomplish by an exchange of several memos will be accomplished with more precision via an exchange of electronic mail message. (Here is one place where even imperfect typing ability would be a real asset.)

2. THE REESTABLISHMENT OF THE CENTRAL FILE

- One of the forgotten casualties of the Xerox Age is the central file, where all correspondence for a company or division was stored, and copies were checked out. Universal copiers doomed the central file.

  - An obvious reason was that it became impossible to control distribution of material when anyone could make a copy.

  - Less obviously, the profusion of "cc's" led to each department's trying to set up its own files; consequently, central files withered. Since most people cannot file accurately, and since indexing/classifying is a rare skill, these subsidiary files are useless as true files; e.g., subjects cannot be retrieved. The subsidiary files are also incomplete and very sensitive to personnel changes.

- Once information has been stored in digitized form it is logically centralized, even if it is stored in two or more locations, as long as complete indexes are available to all users.

  - Regardless of the storage location or requesting location, a copy of the document can be seen by the requestor.

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- Note in the above that a requestor may only be allowed to view the document (on a CRT) but not receive a hard copy. Many levels of access and security are possible.

  - Encrypted data, requiring positive permission to use.

  - Data accessible to specific persons only.

  - Data accessible to specific locations only.

  - Data for viewing only.

  - Hard copy (surprisingly few documents might qualify for this designation, being either too sensitive or too routine.)

- Personal identifiers can be used to provide an access audit trail. Leaks in documentary form and/or by low-level personnel would diminish greatly.

3. COPIERS

- The office convenience copier will become an endangered species in the "office of the future." There are few functions now performed by standalone copiers that will not be superceded by the electronic mail and storage aspects of the "office of the future." Exhibit V-3 shows how current uses would be replaced in the "office of the future."

  - Commercial copy centers and small home copiers would receive a tremendous boost as a result of the inability to do personal copying in the "office of the future."

- Printing (in and out of house) and other duplicating services would undergo tremendous operational changes in the "office of the future." However, these would be replacing like functions; the changes would tend to be transparent to users and management.

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EXHIBIT V-3

REPLACEMENT OF COPIER FUNCTIONS
IN THE OFFICE OF THE FUTURE

EXAMPLES OF CURRENT USE OF COPIERS	ANALOGOUS FUNCTION IN THE "OFFICE OF THE FUTURE"
File copies (office, personal, chron, subject)	Digitized word processor data is indexed (automatically)
Secondary addresses ("cc's")	An index reference is placed in their electronic mail "in-baskets."
Clipping of interest to colleague	(1) Index reference put into colleague's electronic mail in-basket (if material is already digitized) (2) Digitize via image processor and then as in (1) above.
Material for an external recipient	(1) Sent via outside elctronic mail. (2) If recipient does not use electronic mail, central file will generate hard copy and mail.
Recipe from home	(1) Use an outside (e.g., drug-store) copier. (2) Use home copier.

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4. RELIANCE ON PAPER

- Currently, offices both drown and thrive on paper. Interoffice physical paper flow in the "office of the future" will approach zero.

  - The associated need for messenger and mail services will also disappear.

- Within the individual work unit, the situation will not be so clear, and for a long time there will be great variations in paper use. This will depend to some extent on objective differences, but more on personal needs.

  - For some people, draft preparation and editing will still only be possible with paper and pencil.

  - More extreme cases will insist on keeping transitory paper files for reference, rather than using their CRT.

- The situation will be largely self-correcting.

  - Those using the facilities of the "office of the future" will tend to perform better than their old-fashioned colleagues.

  - Those who resist wll be slowly engulfed by those who accept.

  - Offices that retain the old ways will cost much more to run.

- Will the "office of the future" bring with it the problem of drowning in invisible rather than visible information? After all, many computer centers must keep expanding their on-line and off-line storage to deal with a much smaller and more tractable set of data. INPUT does not believe that this is a serious danger.

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- There will, in principle, be only one copy of documents (disregarding backup).

- New mass storage devices will make problems of dealing with current filings much less pressing than paper files are today.

- Very high-density media, such as video disks, will make all documents and data eligible for off-line retrievable storage. Indexes can be similarly stored, but linkable to on-line indexes. ("Off-line" in this case will mean a delay of a few seconds.)

- One of the chief challenges to the Information Resources Director will be to channel the movement toward the "paperless office" so that it occurs in an orderly manner.

  - Overly high expectations by users must be reined in.

  - Those unwilling to change (for nonfunctional reasons) must be either convinced or bypassed.

C. CHANGES IN ORGANIZATIONAL STRUCTURE

- Organizational structures and attitudes toward the "right" structure are constantly changing and will continue to change. The "office of the future" will accelerate those changes by:

  - Changing the balance between the Information Resource Management function and the traditional functions in the organization.

  - Changing the relationship between the organization as a whole and its constituent parts.

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I. THE ROLE OF INFORMATION RESOURCE MANAGEMENT

- As discussed in INPUT's earlier study, Managing the Integration of Office Automation in the EDP Environment, significant organizational changes will be necessary to bring an organization to the point where it can successfully implement the "office of the future."

- Before the "office of the future" can take shape, most of the organization, including top management, will have to accept, largely on faith, both the benefits of the "office of the future" and the proper way to bring these benefits about.

- With the "office of the future" in place, however, the rest of the organization will become believers. At this point organizational change will accelerate. The long-awaited day of information as a resource will have truly arrived.

- There will be more than one attempt to reorganize the organization to take best advantage of the new resource. The Information Resource Director will be listened to avidly by very senior managers. The Information Resources function will have an unparalleled opportunity to join law, finance and engineering as a field that produces top managers.

  - Many EDP/Information Resource Managers will not meet the test.

  - Many EDP managers do not have the breadth of experience, insight or interest in companywide issues.

  - Their technical background is not useful at higher levels, yet they are unwilling to let go of it.

  - Many EDP managers' education and personal characteristics do not provide a foundation for further growth.

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D. EFFECTS ON PERSONNEL AND CHANGES IN PERSONAL BEHAVIOR

- Personal behavior, especially in the short run, can be influenced by organizational actions. Personal behavior is the most difficult area to make long-term changes and, consequently, the most difficult to predict. Each of the major staff groups will be affected differently by the "office of the future."

- The Information Resource Director must be sensitive to the human factors; top management must be sensitized in turn so that the necessary organizational readjustments can take place.

1. CLERICAL STAFF

- Most of the current clerical staff duties will no longer be needed, except for typing/word processing.

- Since there is high turnover in these positions, often there will be no redundancies or formal retraining programs required.

- The existence of clerical staff feeds few egos and confers no status, so there will be few pressures to keep on unneeded staff to do unproductive work.

- Many clericals could be upgraded to low-level technicians (e.g., do their former jobs but in a structured, productive way).

  - Since these jobs would be more interesting, pay more and offer a career path, there should be little clerical resistance to the "office of the future" (if properly presented and managed).

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2. SECRETARIES

- Secretaries are a special case in that, from an objective, functional standpoint, there will be no way to distinguish their future role from other clerical staffs'.

- The correct route will be to change their role from being a dead end to being a technician or true executive assistant.

- However, executive ego-building may require that a significant proportion of the secretarial staff be retained in make-work positions.

- In the long run, this problem will solve itself, since quality people will not wish to be secretaries and, consequently, there will no longer be status conferred in having a secretary.

- In the short run, secretaries will be an expense drain and a drag on the organization's effectiveness, since underemployed staff have poor morale themselves and spread it to others.

3. PROFESSIONAL AND TECHNICAL STAFF

- This is the group that will be the immediate focal point of the "office of the future."

  - They will have the most to gain personally and professionally.

  - They will have the skills required to adopt changes.

  - They will be more accepting of the "office of the future" and will not see their ego or position threatened.

- They will have substantially less on-the-job human contacts than now. As mentioned earlier, a judgement on the long-term effect cannot yet be made.

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- It is not that these people will be in any sense isolated. There will merely be less frustrating, fruitless contact.

- There will be far more scope for working away from the traditional work sites.

- The autonomous work group concept outlined earlier will have powerful attractions to this group.

4. EXECUTIVES

- In the short run, the "office of the future" is least likely to have an impact on executives.

- It may take the "Office of the Future - Model 2" before executives are seriously affected. (On the other hand, it may only require the "Executive of the Future.")

- As executives see what they have unleashed, they will be:

  - Happy for the organization.

  - Uncertain, perhaps fearful, for themselves.

- This uncertainty and fear will be fed by:

  - Seeing their technical subordinates adapting well to the "office of the future."

  - Trying to use it themselves but being unsuccessful (both out of lack of practice and because executive communication and analytic needs may not be served particularly well by the "office of the future").

  - Hearing "success" stories (mainly marketing-inspired) about other executives using the "office of the future."

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- It is important that such executives not undermine the "office of the future." This can be accomplished by admitting that the "office of the future" may not help them in much of their work.

  - It should be repeatedly made clear to all concerned what the "office of the future" can and cannot do.

  - Executives should understand that much of their communication work may still have to involve personal contact.

  - Similarly, their analytical work will often be "subjective" as opposed to the "scientific" approach supported so well by the "office of the future."

- However, it will be a great morale booster to everyone in the organization if executives conform as much as possible to the newly emerging organizational culture. For example, executives should:

  - Observe the telephone "quiet hours" that will spontaneously develop; e.g., no phone conversation except between two and four in the afternoon.

  - Where it is functional, use store and forward like everyone else.

  - Use teleconferencing and electronic mail some of the time, so that people will understand that there is a good reason for executives not using it the remainder of the time.

- If executives are to be able to show that they are "good sports," the "office of the future" must be far more forgiving of neophytes than the automated office is.

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- Systems designers never know, and regular system users usually forget, how puzzling a new machine or feature is to someone unacquainted with it.

- Even now, "user-friendly" usually means friendly to the clerical user, who has received at least several hours' training.

- It is very hard for a machine to be friendly to people who know what they want but don't know how to ask for it. On the other hand, the executive's subordinates are often faced with this problem and solve it. This means that an effective executive terminal in the "office of the future" will:

  - Be able to accept direct handwritten input.

  - Always "check back with the boss" by restating what it thinks it heard.

  - Be able to respond to terse, variable commands; e.g., "Make appts.," "Appts.," "Set up mtgs with."

  - Be forgiving on spelling.

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- Survey Fortune 500/50 companies to determine plans for distributed data processing.

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- Determine the market potential for an associative Relational Data Base Management System Processor.

- Conduct the 1980 ADAPSO Survey of the Computer Services Industry.

- Analyze the opportunities and problems associated with packaging terminals and/or minicomputers with remote computing services.

ABOUT INPUT

THE COMPANY

INPUT provides planning information, analysis, and recommendations to managers and executives in the information processing industries. Through market research, technology forecasting, and competitive analysis, INPUT supports client management in making informed decisions. Continuing services are provided to users and vendors of computers, communications, and office products and services.

The company carries out continuous and in-depth research. Working closely with clients on important issues, INPUT's staff members analyze and interpret the research data, then develop recommendations and innovative ideas to meet clients' needs. Clients receive reports, presentations, access to data on which analyses are based, and continuous consulting.

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Formed in 1974, INPUT has become a leading international consulting firm. Clients include over 100 of the world's largest and most technically advanced companies.

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